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RODENT POPULATIONS AFTER A LARGE WILDFIRE IN CALIFORNIA CHAPARRAL AND COASTAL SAGE SCRUB

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ABSTRACT—Rodent populations were sampled at sites in California chaparral and coastal sage scrub six months after wildfire. Sites adjacent to unburned brush were compared with sites in the center of large burned areas. Eight species of rodents were captured. Species of *Peromyscus* were the most abundant, 40.2% of individuals captured; followed by *Neotoma* (32.4%), *Chaetodipus* (20.3%), and *Dipodomys* (7.0%). *Peromyscus maniculatus* accounted for 32.8% of all individuals and was captured most frequently at sites in the center of large burns. *Neotoma lepida* which accounted for 31.3% of individuals captured, was trapped most commonly at the periphery of burns. Several species showed contrasting distribution patterns in coastal sage scrub and in chaparral. Coastal sage scrub sites had the highest estimates of rodent populations. Species diversity varied widely among sites.

RESUMEN—Se tomaron muestras de poblaciones de roedores en seis sitios en California con vegetación de chaparral y matorral de artemisa de la costa seis meses después de un incendio natural. Se compararon sitios contigüos al matorral no quemado con sitios en el centro de áreas grandes quemadas. Ocho especies de roedores fueron capturadas. Las especies de *Peromyscus* fueron más abundantes (40.2% del total de los individuos capturados), seguidas de *Neotoma* (32.4%), *Chaetodipus* (20.3%) y *Dipodomys* (7.0%). *Peromyscus maniculatus*, que constituyó el 32.8% del total, fue capturado más frecuentemente en los sitios del centro de las quemas grandes. *Neotoma lepida*, que constituyó el 31.3% de indiviuos capturados, fue atrapado más comunmente en las orillas de las quemas. Algunas especies mostraron patrones contrastantes de distribución en los habitat de matorral de artemisa de la costa y chaparral. Las más altas estimaciones de poblaciones de roedores se encontraron en las zonas de matorral de artemisa de la costa. La diversidad de especies varió mucho entre los sitios.

Although effects of wildfire on chaparral and coastal sage vegetation have been studied extensively, little is known regarding post-fire recolonization by rodents that inhabit these communities. The few previous studies on this subject have been on small burns and without replicate sites (Lawrence, 1966; Wirtz, 1982; Price and Waser, 1984). Previous studies indicated that although burrowing animals may escape death in a wildfire, few can survive intense burns (Howard et al., 1959; Lawrence, 1966). Post-fire succession, therefore, likely depends on migration from unburned areas. Differing migration rates among rodent species may lead to different post-fire communities at sites adjacent to and sites distant from unburned shrub cover.

This study examines post-fire recovery of rodent populations within coastal sage scrub and chaparral communities in the Santa Monica Mountains of southern California. The study area burned in the Green Meadow Fire which occurred in late October 1993 and consumed 16,215 ha in Ventura Co., California. We compared rodent density and species composition of sites distant from unburned areas and sites adjacent to unburned areas to determine whether distance from unburned brush or vegetation type (chaparral or coastal sage) had the greater effect on post-fire community structure. Live trapping and mark-recapture methods were used to estimate the size of rodent populations throughout summer following the wildfire.

TABLE 1—Study sites in Big Sycamore Canyon, Point Mugu State Park, Ventura Co., California. Sites are ranked 1–6 according to distance from unburned areas: 1 = closest to unburned areas, 6 = center of burned area.

Aspect	Incline (°)	Elevation (m)	Vegetation	Distance (km) from unburned brush	
				Rank	Distance
300° (NW)	31°	75	coastal sage	2	adjacent
190° (S)	22°	110	coastal sage	3	1.5
121° (E)	23°	130	coastal sage	6	6
310° (NW)	29°	210	chaparral	1	adjacent
330° (NW)	22°	170	chaparral	4	2
180° (NW)	21°	100	chaparral	5	5

MATERIALS AND METHODS—All study sites were within Point Mugu State Park, Ventura Co., California. The six sites (Table 1), all in Big Sycamore Canyon, included coastal sage scrub sites in the lower canyon and chaparral sites farther up the canyon. Sites ranged in elevation from 75 m to 210 m. Two sites were distant from unburned brush (>5 km), two were adjacent to large unburned areas, and two sites were intermediate (1 and 2 km from unburned brush).

A 110-m transect was placed at each site with trap stations every 5 m for a total of 23 stations per transect. At each station two Sherman live traps were positioned approximately 1.5 m apart. Traps were baited with rolled oats in the afternoon and collected at sunrise. Animals were identified, weighed, toe-clipped, and sex was determined before they were released.

Beginning in June 1994, two sites were sampled each week for three consecutive nights, so that each site was sampled three times at three-week intervals over the nine-week study for a total of 2,484 trap-nights. Recapture data were used to estimate population sizes for each three-night trapping period. Population estimates were made from mark-recapture data according to Bailey's (1951) modification of the Lincoln Index. In cases where number of individuals was too small to provide a population estimate by this method, the minimum number of individuals known to be alive was used in place of the Lincoln Index estimate. These estimates allow only a comparison of relative population sizes among the six sites because the area from which rodents were drawn is unknown.

Number of individuals captured per site, rather than population estimates, were used in all statistical analysis. Analysis of variance was used to compare number of rodents captured at coastal sage scrub sites with number captured at chaparral sites. Correlation between rodent capture rates and distance from unburned brush was tested with Spearman rank correlation. Species richness was recorded at each site and diversity was calculated using the Shannon-Wiener Index, $H' = -\Sigma_i p_i \ln(p_i)$, (i = 1,2,3, . . . , S), where S is species richness and p_i is proportion of the total number of individuals belonging to species i.

TABLE 2—Mean weights and sex ratios of small mammals captured at Point Mugu State Park, June to August 1994. Mean adult weights are shown ±1 *SE*.

Species	Adult weight (g)	Individuals captured	
		n	males : females
Chaetodipus californicus	26.5 ± 0.6	52	2.20
Dipodomys agilis	69.6 ± 1.4	18	0.64
Neotoma fuscipes	199.5 ± 80.5	2	(2:0)
Neotoma lepida	137.2 ± 4.2	80	1.10
Peromyscus boylii	21.7 ± 1.4	16	0.68
Peromyscus californicus	36.0 ± 0.0	1	(1:0)
Peromyscus eremicus	20.0 ± 2.0	2	1.00
Peromyscus maniculatus	19.8 ± 0.5	84	1.47
Total:		255	

TABLE 3—Mean population estimates based on mark-recapture data from three trapping periods for six sites in Point Mugu State Park, California (− = absent, + = mean density <1.0); sites are arranged in increasing distance from the edge of unburned coastal sage or chapparal. *Neotoma fuscipes, Peromyscus boylii, P. californicus,* and *P. eremicus* are not included due to low trapping rates (≤2 individuals). Species richness and Shannon-Wiener diversity index values are presented for each site.

	Coastal sage (km from edge)			Chapparal (km from edge)		
	Adjacent	1.5	6	Adjacent	2	5
Chaetodipus californicus	−	4.3	5.0	2.7	3.3	−
Dipodomys agilis	−	1.3	−	−	1.7	2.7
Neotoma lepida	12.0	5.3	7.7	−	+	3.0
Peromyscus boylii	2.3	−	+	+	2.3	−
Peromyscus maniculatus	4.7	6.0	9.3	−	3.3	6.0
Overall mean density		57.0			28.3	
Species richness	5	4	3	4	5	3
Species diversity (H')	1.2	1.3	1.1	0.8	1.5	0.5

RESULTS—Four genera and eight species of rodents were captured during this study (Table 2). Total number of captures was 405 (trap success = 16.3%); 255 individuals were captured. *Neotoma lepida* (nomenclature according to Jameson and Peeters, 1988) accounted for the greatest number of captures, although many were recaptures, and *Peromyscus maniculatus* accounted for the largest percentage of individuals captured (32.8%). Although *P. maniculatus* was captured at all sites except one (Table 3), the greatest number of captures was near the center of the burn, and capture of this species was correlated positively with distance from unburned brush (Spearman rank correlation, $r = 0.714$). Other species of *Peromyscus* (*P. boylii, P. californicus* and *P. eremicus*) accounted for 7.4% of all individuals captured. Only *P. boylii* was found at more than one site, but captures were not associated with either vegetation type or distance from unburned brush (Table 3). Woodrats were captured at every site, but *N. lepida* was much more common than *N. fuscipes.* Woodrats were the largest animals trapped in this study (Table 2) and exhibited the highest recapture rate; 42.9% of all woodrats were recaptured at least once. *Chaetodipus californicus* accounted for 18.8% of all captures and was captured most frequently in burned areas of coastal sage scrub (Table 3). *Dipodomys agilis* was captured at three sites and accounted for 7.9% of all captures. *Dipodomys* were found at the three sites with the most gradual slopes (less than 22°) and were not found at either of the two sites closest to unburned areas. Males were captured more frequently for *Peromyscus* but the sex ratio of *N. lepida* was even (Table 2). For both *C. californicus* and *D. agilis,* females were more frequently captured (Table 2). The mean population estimate of rodents at coastal sage brush sites (57) was significantly higher than the mean number at chaparral sites (28.3; $F_S = 13.3$; $v = 1,4$; $P = 0.022$). Species richness and diversity (H') did not appear to be related to either habitat type or distance from unburned vegetation (Table 3).

DISCUSSION—This study is limited to a short period following the fire, but it does reveal some intriguing patterns. Three species of rodents, *N. fuscipes, P. californicus,* and *P. eremicus,* were captured in few numbers and only at the edge of the burn. These species more common to mature chaparral were excluded from further analysis. Distance from unburned brush was positively correlated with abundance of *P. maniculatus* across both vegetation types, but other species showed different patterns in the two vegetation types. Populations of *C. californicus* were highest on the edge of chaparral, but this pattern was reversed for coastal sage scrub. Both *D. agilis* and *N. lepida* also showed opposite patterns in the two vegetation types: numbers increased toward the center of the burn in chaparral and decreased away from the burn edge in coastal sage scrub.

Peromyscus maniculatus is a recognized generalist in food and habitat (M'Closkey, 1972; Meserve, 1977; Holbrook, 1978), and typically is found in recent burns (Lawrence, 1966; Fell-

ers, 1994; Price et al., 1995; Wirtz, 1995). In this study, *P. maniculatus* appears especially drawn into the burn areas of coastal sage scrub, perhaps in response to food provided by postfire annuals. This potential resource in burned coastal sage scrub may help explain the significantly higher numbers of rodents captured in this vegetation type.

Although *Neotoma* are reported to be relative latecomers to the post-fire rodent community, rarely occurring earlier than 20 months after fire (Wirtz, 1982, 1995), we found *N. lepida* at all coastal sage scrub sites within 6 months after wildfire. At sites adjacent to unburned coastal sage scrub, this result is not surprising; woodrats are known to forage long distances from their nests (Cranford, 1976). For sites more distant from unburned brush, the appearance of *Neotoma* might be explained by either survival during fire (perhaps more likely in coastal sage scrub than in intense chaparral fires) or longer migratory movements.

Variation in species composition among sites that all burned at the same time was not consistently correlated with either vegetation type or distance from unburned brush. We suggest three possible explanations for the lack of correlation between rodent density and distance from unburned vegetation: 1) rapid migration from unburned areas may have occurred before the beginning of this study; 2) rodents may have survived intense fires; and 3) lightly burned habitat patches in the canyon bottoms may have acted as potential refuges and sources for recolonization. Additionally, it appears that several species show different distributions relative to unburned brush depending on the type of post-fire vegetation.

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